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with the presence in the group of small spots or eruptive flocculi. This type is a very common one. In fact, the two spots at the opposite ends of a group are almost invariably found to be of opposite polarity, accompanied by $H\alpha$ flocculi showing this structure. Moreover, photographs of the flocculi made with the hydrogen lines $H\beta$, $H\gamma$ and $H\delta$ bring out the general features of the type (though less clearly than $H\alpha$), so that the resemblance to lines of force was detected in my earliest photographs of the hydrogen flocculi, made with $H\beta$ and $H\gamma$ in 1903. Even the H_2 and K_2 flocculi and the faculæ in direct photographs, show a similar structure.

Multipolar, usually surrounding groups containing several spots, and sometimes persisting after the spots have disappeared. The disturbed area, frequently of enormous extent, is roughly elliptical in form, with long, curved flocculi, of peculiar structure, directed toward the interior. Generally the major axis of the ellipse is nearly parallel to the long axis of the spot group. An excellent example may be found in my paper on "Solar Vortices."[1]

Sometimes the multipolar type is associated with, or hardly distinguishable from the bipolar, and both multipolar and bipolar flocculi have been found with flocculi of the unipolar type. In spite of this fact, and the obvious necessity of providing for subdivisions of the above types, the distinction between the unipolar, bipolar, and multipolar forms will be readily recognized in examining a long series of good photographs of the Sun made with $H\alpha$.

In addition to the above types, the dark *filaments* and the bright eruptions must of course find a place in a general classification of the hydrogen flocculi. George E. Hale.

A Radial Velocity of Comet *a* 1910.

It is only very rarely that an accurate radial velocity of a comet can be obtained by means of the spectrograph, for two reasons: few comets are sufficiently bright to permit the use of high dispersion, and there must be present in the comet spectrum lines whose wave-lengths are accurately known.

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[1] *Astrophysical Journal,* **28**, Plate VI, September, 1908.

Comet *a* 1910 offered such an opportunity, for it was bright, and the well-known D-lines, due to sodium, were present as emission lines.[1]

On January 27 the D-lines were photographed with a grating spectrograph attached to the 36-inch refractor. The second order was employed, and a sodium flame was used as the source of the comparison spectrum. Both D_1 and D_2 of the comet spectrum are recorded on the plate. D_2 shows considerable strength, and can be measured quite accurately, while D_1, being very faint, is difficult to see under the microscope, and its measured displacement must consequently be given small weight. The radial velocity referred to the center of the Earth, as obtained from the measures of D_2, was $+ 63.3^{km}$. (D_1 gave $+ 77.4^{km}$. It is so faint and difficult of measurement that it was given only one-fourth weight.) This displacement was assumed to be due mostly to the radial velocity of the comet with respect to the Earth, though it was thought possible that a minor part of it might be due to other causes, as for example an initial velocity of ejection of the sodium vapor from the nucleus. From elements of the comet by KOBOLD (in *Astronomische Nachrichten,* 4385) the computed radial velocity relative to the Earth for the date of observation was found to be $+ 62.7^{km}$. The agreement of the computed velocity with the value obtained from the measures of D_2 shows that the displacement of the sodium lines was due practically entirely to the former cause.

The only previous radial velocity determinations of comets of which I have been able to find a record were visual determinations made by estimating the displacements of the bright D-lines in the spectrum of the great comet of September, 1882, by MM. THOLLON and GOUY, and at Lord CRAWFORD'S Observatory.[2]

In this connection it may be of interest to note the practical possibility of utilizing radial velocity determinations in the computation of the preliminary orbit of a bright comet. The approximate readings of the circles of the telescope would give the data which are necessary to refer the velocities to the Sun, and would also give a rough orientation of the orbit. Such an orbit, however, would not be comparable in accuracy to an orbit computed from accurate observations of position. MOULTON[1] has developed a method for the determination of a parabolic orbit from two observations of apparent position, and one of the motion in the line of sight. The difficulty of obtaining accurate positions of this comet during the first week after announcement of its discovery indicates that radial velocities might find a useful practical application on rare occasions like the present one. The D-lines were sufficiently intense in the comet's spectrum to warrant the belief that it would have been entirely possible, weather permitting, to have photographed them with high dispersion in broad daylight on the first few days after the discovery of the comet.

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[1] *Lick Observatory Bulletin,* No. 174.

[2] *Observatory,* **6**, 94, 1883.

S. ALBRECHT.

April, 1910.

ASYMMETRICAL LINES IN SUN-SPOT SPECTRA.

In a note on the classification of the lines in sun-spot spectra, which appeared in the last number of these *Publications,* I omitted to mention the asymmetrical lines, which promise to be of great interest when additional laboratory data become available for purposes of comparison. Some remarkable cases of asymmetry not at first supposed to be such because of their wide departure from the normal type, have recently been detected. Extensive investigations on the Zeeman effect for chromium, nickel, and other elements, upon which Dr. KING and Mr. BABCOCK are now engaged, will soon show the behavior of these lines in the laboratory.

In addition to the triplets and quadruplets mentioned in the same note, lines split by the magnetic field into a greater number of components undoubtedly appear in sun-spot spectra, though they are not resolved on our present photographs.

GEORGE E. HALE.

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[1] *Astrophysical Journal,* **10,** 14, 1899.